



Maskless Nanostructure Definition of Submicron Rear Contact Areas for Advanced Solar Cell Designs

Davidson, Rasmus Schmidt; Schmidt, Michael Stenbæk; Boisen, Anja; Hansen, Ole

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Davidson, R. S., Schmidt, M. S., Boisen, A., & Hansen, O. (2015). *Maskless Nanostructure Definition of Submicron Rear Contact Areas for Advanced Solar Cell Designs*. Poster session presented at 41st International conference on Micro and Nano Engineering , The Hague, Netherlands.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Maskless Nanostructure Definition of Submicron Rear Contact Areas for Advanced Solar Cell Designs

Rasmus Schmidt Davidsen^{*,a}, Michael Stenbæk Schmidt^a, Anja Boisen^a, Ole Hansen^a

^aDTU Nanotech, Technical University of Denmark, Ørstedes Plads 345, 2800 Kgs. Lyngby, Denmark

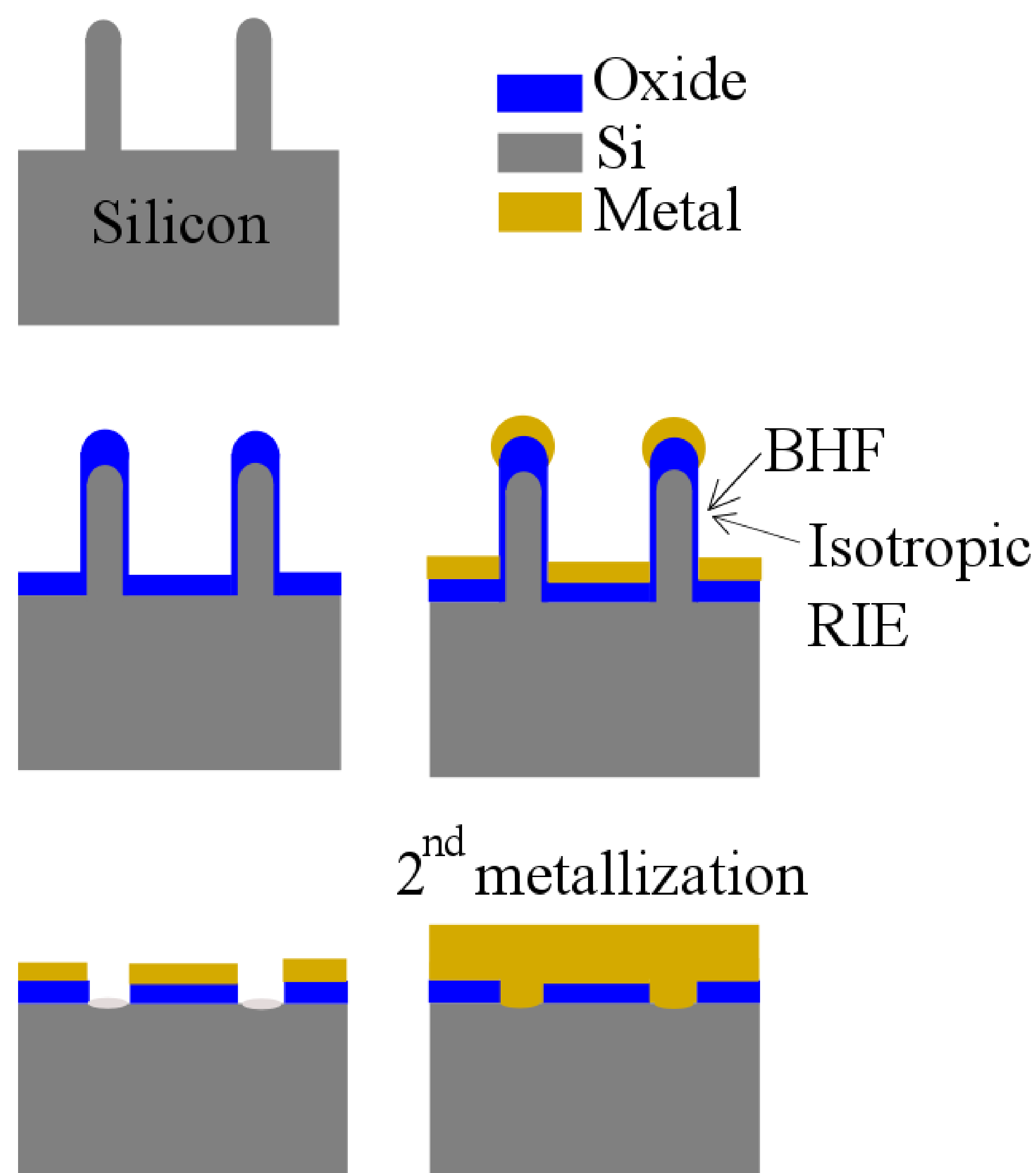
*e-mail: rasda@nanotech.dtu.dk



Concept

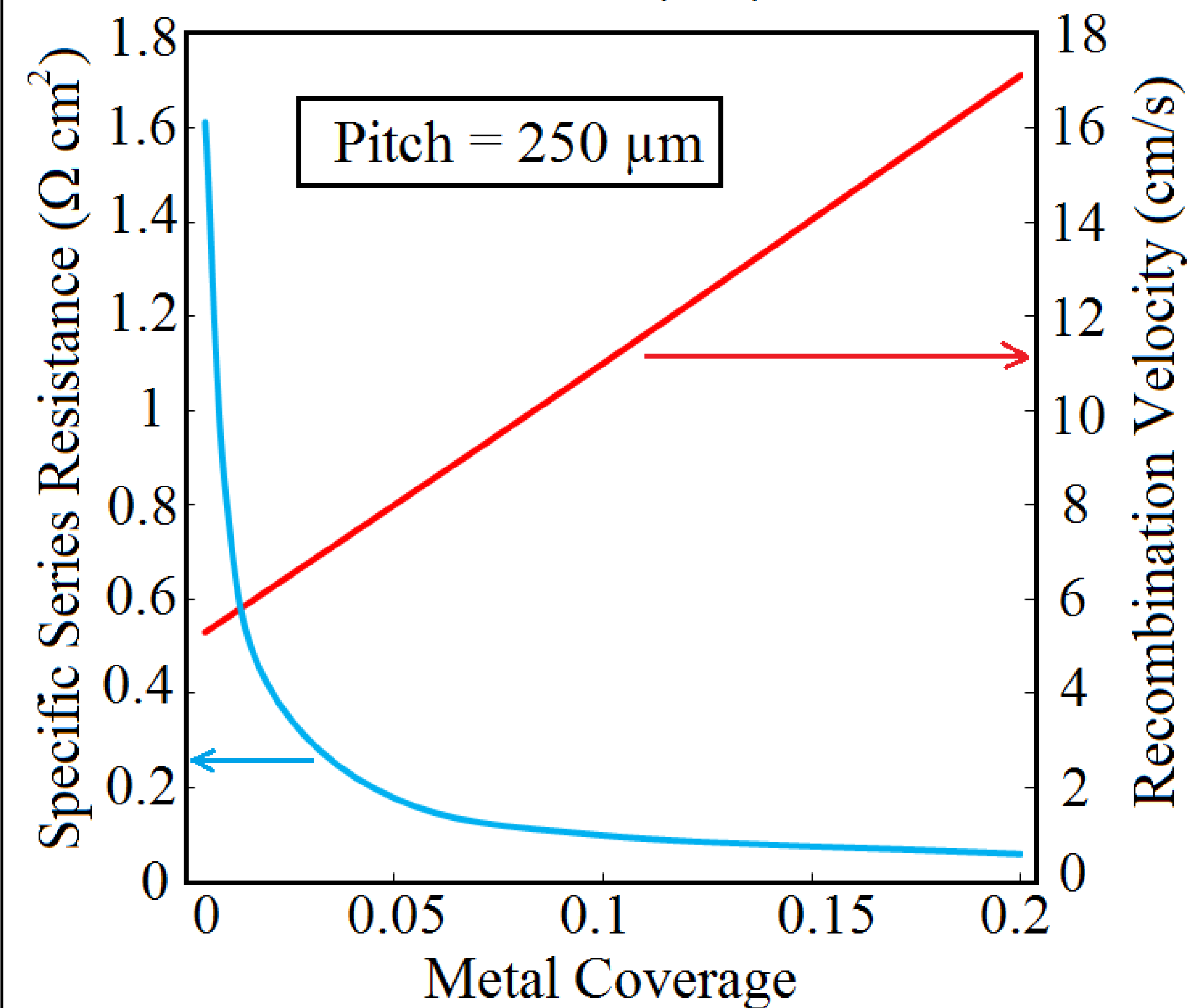
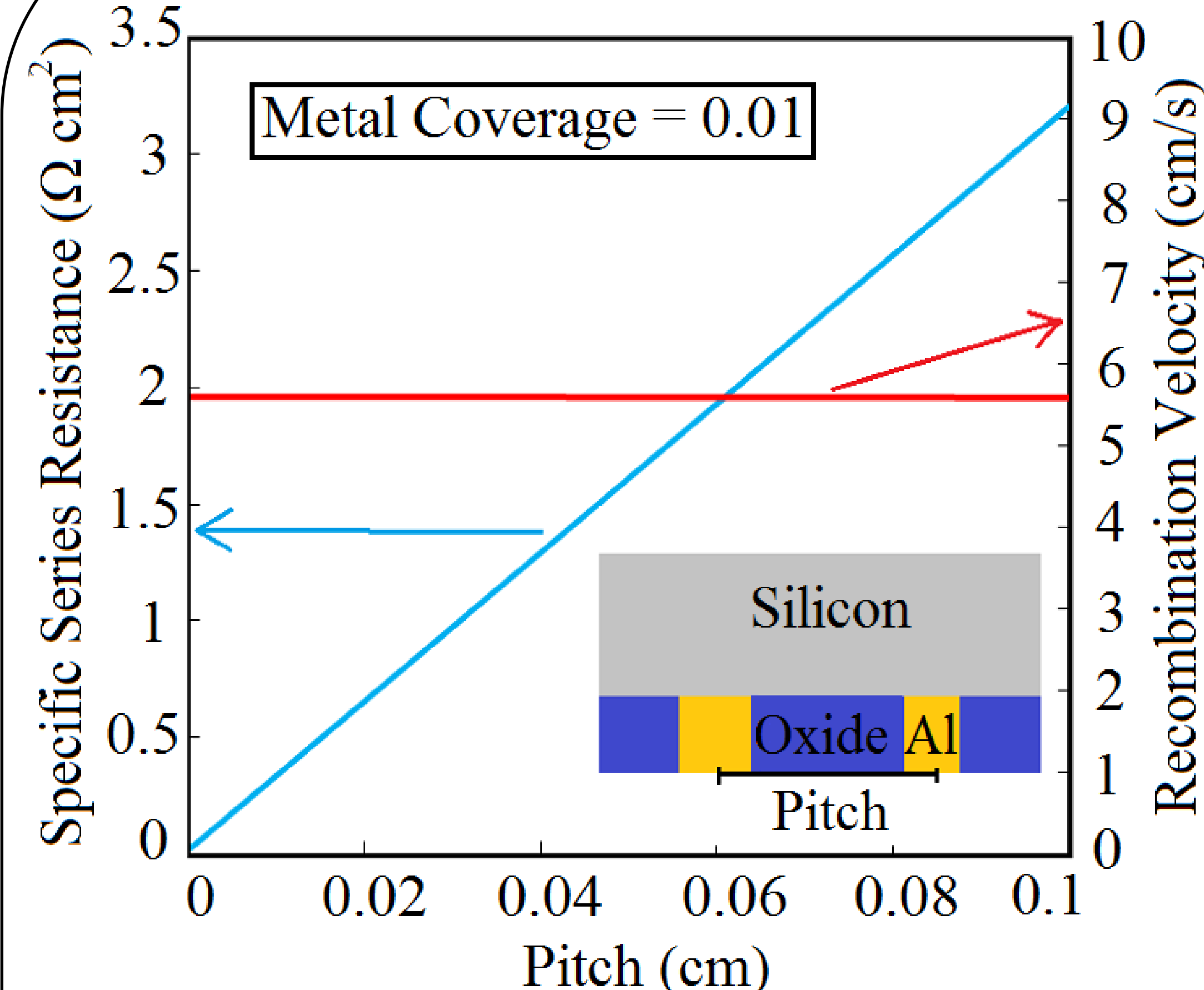
Nanostructures are fabricated by maskless reactive ion etching (RIE) [1,2] using SF_6 and O_2 ions. Maskless RIE enables precise definition of nanostructured topologies with specific pitch and size without the use of photolithography. The optimal rear design of the world-record passivated emitter rear locally diffused (PERL) solar cell [3] is a compromise between minimized series resistance, requiring some metallization, and minimized SRV, requiring passivation.

We present a completely maskless process for controlled definition of submicron local contact areas on a passivated Si surface.



Sketch of the process flow consisting of maskless nanopillar etch, passivation, Al evaporation, isotropic RIE of pillar sidewalls and 2nd metallization plus optional doping.

Calculations



Calculated surface recombination velocity[4] and specific series resistance of a passivated Si surface as function of the pitch between contact openings (top) and metal coverage (bottom), respectively.

Experimental Results



(Top) SEM-image of the nanopillar surface covered with Al **before** isotropic Si etching. The pillar density is $\approx 3 \mu\text{m}^{-2}$, which corresponds to a potential metal to Si fraction of 2.4%.



SEM-image of the surface **after** isotropic RIE. The etching process has removed most of the nanopillars and created holes in the passivated Si surface covered with metal.

Conclusion

In this work, we present a completely maskless process allowing for controlled definition of local contact areas on a passivated Si surface without any use of lithography and with a submicron feature size and controllable pitch between contact openings. The metal to Si fraction was estimated to 2.4 % and the feature size a few hundred nanometers.

The method allows for a much lower pitch than lithographically defined patterns, while maintaining the targeted metal to Si fraction.

The technique has the potential for realizing advanced high-efficiency solar cell concepts, such as the PERL-cell, without the use of photolithography.



Rasmus S. Davidsen
PhD-student,
DTU Nanotech
Technical University
of Denmark

Email: rasda@nanotech.dtu.dk
Phone: +45 26187249

DTU Nanotech
Department of Micro- and Nanotechnology

References

- [1] Repo, P., Benick, J., Vähänissi, V., Schön, J., von Gastrow, G., Steinhauser, B., Schubert, M.C., Hermle, M., Savin, H., "N-type black silicon solar cells", *SiliconPV, Energy Procedia* 38 866-871 (2013).
- [2] Davidsen, R., Ormstrup, J., Ommen, M.L., Larsen, P.E., Schmidt, M.S., Boisen, A., Nordseth, Ø., Hansen, O., "Angle resolved characterization of nanostructured and conventionally textured silicon solar cells", *Solar Energy Materials & Solar Cells* 140 (2015) 134–140
- [3] Zhao, J., Wang, A., Green, M.A., "24.5% Efficiency silicon PERT cells on MCZ substrates and 24.7% efficiency PERL cells on FZ substrates." *Prog. Photovoltaics: Research & Applications* 7.6 (1999) 471-474
- [4] Benick, J., Hoex, B., van de Sanden, M.C.M., Kessels, W.M.M., Schultz, O., Glunz, S.W., "High efficiency n-type Si solar cells on Al_2O_3 -passivated boron emitters" *Appl. Phys. Letters* 92, 253504 (2008)